

## CLAIMS

1. A method of providing a real-time panoramic video image in a rectangular format; the method comprising the steps of:
  - a) providing a panoramic annular lens system to capture a 360° viewed annular image;
  - b) focusing said 360° viewed annular image on a video camera image plane;
  - c) transferring a data signal output of said camera image plane to a personal computer;
  - d) utilizing said personal computer to unwrap said annular image into a substantially distortion free rectangular image at a rate of at least 30 fps; and
  - e) presenting said rectangular image on a visual display.
2. The method recited in claim 1 wherein in step a) providing said panoramic annular lens system comprises the step of providing a hyperboloidal lens and ellipsoidal mirror.

1           3. The method recited in claim 1 wherein in step b) providing said video  
2 camera comprises the step of providing a CCD image plane.

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5           4. The method recited in claim 1 wherein in step b) providing said video  
6 camera comprises the step of providing CMOS image plane.

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9           5. The method recited in claim 1 wherein step d) comprises the steps of  
10 utilizing radiometric ray tracing to first convert said annular image to a distorted  
11 unwrapped image and then to convert said distorted unwrapped image to an  
12 undistorted unwrapped image.

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15           6. The method recited in claim 1 wherein step d) comprises the step of  
16 employing a vertex-based transformation using graphics processing units of said  
17 personal computer.

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20           7. The method recited in claim 1 wherein step d) comprises the steps of  
21 capturing said data signal output; converting said video image from said data  
22 signal output; manipulating said converted video image; and rendering said  
23 image in Cartesian format.

1           8. The method recited in claim 1 wherein step d) comprises the step of  
2    using at least one graphics card of said personal computer to unwrap said  
3    annular image.

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6           9. An apparatus for providing a real-time panoramic video image in a  
7    rectangular format; the apparatus comprising:  
8           a panoramic annular lens system configured for capturing 360° viewed  
9    annular image;  
10          a video camera having an image plane for receiving said annular image  
11    and generating a corresponding data signal output;  
12          a computer receiving said data signal output;  
13          a graphics card and at least one software module in said computer for  
14    unwrapping said data signal output from an annular image into a substantially  
15    undistorted rectangular image at a rate of at least 30 fps; and  
16          a visual display for displaying said rectangular image.

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19          10. The apparatus recited in claim 9 wherein said panoramic annular lens  
20    system has a hyperboloidal lens and an ellipsoidal mirror.

1           11. The apparatus recited in claim 9 wherein said video camera has a  
2    CCD imaging plane.

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5           12. The apparatus recited in claim 9 wherein said vide camera has a  
6    CMOS imaging plane.

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9           13. The apparatus recited in claim 9 wherein said software module has a  
10   program for radiometric ray tracing to first convert said annular image to a  
11   distorted unwrapped image and then to convert said distorted unwrapped image  
12   to an undistorted unwrapped image.

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15           14. The apparatus recited in claim 9 wherein said software module has a  
16   program for vertex-based transformation for unwrapping said annular image.

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19           15. The apparatus recited in claim 9 further comprising means for  
20   capturing said data signal output; means for converting said video image from  
21   said data signal output; means for manipulating said converted video image; and  
22   means for rendering said image in a Cartesian format.

1           16. A panoramic video system having real-time distortion-free imaging;  
2   the system comprising:  
3           a panoramic optical system having at least one optical element for  
4   viewing a 360° field of view and focusing a corresponding image on an image  
5   plane;  
6           a video camera having a sensing element at said image plane for  
7   converting said image into a corresponding video signal;  
8           a computer receiving said video signal and having at least one program  
9   for configuring a substantially distortion-free rectangular display of said image at  
10   a rate of at least 30 fps; and  
11          a monitor for presenting said display.

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14          17. The panoramic video system of claim 16 wherein said optical system  
15   optical element comprises an annular element and said corresponding image is  
16   an annular image of said 360° field of view.

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19          18. The panoramic video system of claim 16 wherein said video camera  
20   comprises a CCD sensing element.

1           19. The panoramic video system of claim 16 wherein said video camera  
2 comprises a CMOS sensing element.

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5           20. The panoramic video system of claim 16 wherein said video camera  
6 sensing element has a pixel resolution of at least 1280 x 1024.

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9           21. The panoramic video system of claim 16 wherein said video camera  
10 sensing element has a pixel resolution of at least 720 x 480.

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13           22. The panoramic video system of claim 16, said computer comprising at  
14 least one graphics card for configuring said rectangular display.